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GLASS SEALING MATERIAL FOR CONDUCTIVE SPARK PLUG

[Tenkasen-no dodensai garasu shitsu shiiru zairyo]

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Claim

A glass sealing material for a conductive spark plug made by sealing a center electrode, divided into an electrode shaft and an electronic shaft, into a shaft hole in a spark plug insulating glass tube containing 30-70 wt% of a borosilicate group glass powder, the remainder being a conductive metal powder, which tube is used to connect both shafts by means of conduction, the invention is characterized by compounding one, two or more selected from the group comprising Sn, Sb, Al, Pb, Te and Zn as part of the conductive metal powder in the range of 2-23 wt%.

Detailed explanation of the invention

[0001] The present invention relates to a glass sealing material for a conductive spark plug.

[0002] This sealing material is used to connect by conduction a center electrode, divided into an electrode shaft and an electron shaft, directly or by using a resistor, sealed inside the shaft hole of the insulating glass tube for spark plug.

[0003] Here, the resistor is useful in preventing static or an interfering [illegible] from occurring during spark discharge from a spark plug. Often, a resistance fine wire or a resistor obtained by winding a conductive fine wire, an inductor or a ceramic resistor molded and processed separately that were wound around a resistance ridge, that is, the winding core of the insulator were sealed and fixed between the electrode shaft and the terminal in the shaft hole of the insulating glass tube. In addition, the electrode shaft and the terminal shaft were heated beforehand using a conductive glass sealing material and a glass resistance raw material compounded so that the desired resistance value was obtained beforehand and the resistor was formed inside the shaft hole.

[0004] In the prior art, mixtures of conductive metal powder such as the conventional borosilicate group glass powder and Cu or Fe having a weight ratio of nearly 1:1 were often used as a conductive

glass sealing material whether or not the abovementioned resistor was sealed inside. However, when this type of sealing material was actually used, the wetting characteristics of the glass seal relative to the electrode shaft and the terminal shaft were poor and it tended to become fixed to both shafts of the sealed glass, and there was the possibility that it would become softer.

[0005] Therefore, in order to solve the abovementioned problems, the present invention was attained by carrying out a great deal of research and development on added constituents which were capable of improving the wetting characteristics of the electrode shaft and the terminal shaft, which were not accompanied by deterioration of the sealing action and the conductivity.

[0006] The constituents found by the inventor to improve the wetting characteristics are a metal or alloy powder comprised of one, two or more selected from the group of Sn, Sb, Zn, Te, Pb and Al. A suitable amount of this is mixed in instead of the conductive glass powder and the obtained conductive glass sealing material is deposited on the peripheral surface of the electrode shaft and the terminal during the sealing operations for the electrode shaft and the terminal shaft for the spark plug, carried out at a temperature of approximately 900°C since any constituent used to improve the abovementioned wetting characteristics has a low melting point. Sealing can be carried out by tightly fixing each of the shafts without any [illegible] while the spark plug is being used. As a result, the durability of the glass-sealed spark plug as well as the glass-sealed spark plug with resistance are noticeably improved.

[0007] In particular, when applying the present invention for a glass seal for a spark plug with resistance, the load lifetime characteristics are improved. As a result, one, two or more types selected from the group comprising IVa, Va and VIa group metals in the periodic table, as well as oxides and carbides of rare earth elements (TiO_2, ZrO_2, ThO_2, Nb_2O_5, Ta_2O_5, Cr_2O_3, La_2O_3, TiC, VC, NbC, TaO, Cr_3O_2, Mo_2C, WC and La_2O and the like), as well as MgO, ZnO, B_4C, SiC, TiB and TiN can be compounded at the same time in a range of 1-30 parts by weight with respect to 100 parts by weight of

the mixture of borosilicate glass and conductive metal powder. In particular, even among the glass resistance raw materials used for the resistor, this constituent, which improves the load lifetime characteristics, takes a mixture of borosilicate barium glass, a skeleton used in the ceramics industry and a carbon material, and packs them along with a glass sealing material inside the shaft holes of the spark plug insulating glass tube and heats them. This is pressurized to below the softening state of each of the glass constituents and the electrode shaft and the terminal shaft are sealed. At the same time, when the resistor is being formed, the load lifetime characteristics of the spark plug can be prevented from deteriorating over time when the resistance value increases.

[0008] Incidentally, the load lifetime characteristics are evaluated using the rate of change in the resistance value after a 250 h durability test under the restricted conditions indicated in JIS D5102 item 4,4,4. The result is within 30%, meaning that it meets the requirements for practical application.

[0009] Next, we shall validate the effect in experimental examples of the present invention.

[0011] <u>Experimental Example 1</u>

[0012] Glass-sealed spark plug

[0013] The various conductive glass sealing materials indicated in Table 1 are packed at 0.4 g inside the shaft hole at the very top by latching onto the [illegible] part of a Ni alloy electrode shaft which is inserted inside the terminal hole that is elevated relative to the terminal hole having a hole diameter of 2.8 mm and a length of 16 m adjacent to the shaft hole extending over hole diameter of 4.6 mm and a length of 49.5 mm on an insulating glass tube made of a high-alumina ceramic. The mean value of the time until a loosening occurs in the electrode shaft and the terminal shaft by carrying out the heating shock tests for the glass seal spark plugs at the various sites, and obtained by inserting and fastening the

terminal shaft by a constant load of 12 kg when the glass, which has been maintained at 930°C for 7 min, is indicated in Table 1.

TABLE 1

	Conductive Glass Sealing Material Composition (wt%)								Heating Shock Test	
	Glass	Cu	Sn	Sb	Al	Pb	Te	Zn	Center electrode loosening Occurrence/time	
1	50	50	0*						15	minutes
2	"	49	1*						15	"
3	"	48	2						30	"
4	"	40	10						90	"
5	"	27	23						30	"
6	"	25	25*						15	"
7	"	45		5					45	"
8	"	"			5				35	"
9	"	"				5			50	"
10	"	"					5		40	"
11	"	"						5	40	"
12	"	"	3	2					60	"
13	"	43			5		2		45	"
14	"	"				2		5	55	"

Note: The glass in the table is borosilicate [illegible] glass having 65% SiO_2, 30% B_2O_3 and 5% PbO.

* Comparative example outside parameters

[0014] Furthermore, the heating and shock test was carried out using a test device indicated in JIS B8031-1968, item 4,4,4. The front end of the center electrode was heated to approximately 800°C

beforehand with a burner and shock of 400 times/min was applied. We inspected the occurrence of loosening of the center electrode at 5 min intervals.

[0016] Experimental Example 2

[0017] Glass-sealed spark plug with Resistance

[0018] 0.2 g and 0.4 g of each of the conductive glass sealing materials indicated in Table 2 were packed into the shaft hole in the same type of insulating glass tube as used in Experimental Example 1, into which was inserted an electrode shaft so that that 0.3 g of a glass resistance material made by compounding 26 wt% of borosilicate barium glass (65% B_2O_3, 35% BaO), 65 wt% a skeleton ("frog eye" clay:zircon 1:1), 1 wt% carbon (glycerol) and 8 wt% TiO_2 was clamped between. This was heated at 930°C and kept at this temperature for 7 min. A heating shock test was carried out for 10 spark plugs pressed in and fastened while the glass was kept in a softened state at a constant weight of 12 kg and we obtained the results indicated in Table 2.

TABLE 2

	Conductive Glass Sealing Material Composition (wt%)					Heating Shock Test
	Glass	Cu	TiO_2	TiO	Sn	Center electrode loosening time
15	45	50	5	0	0*	15 min
16	45	45	5	0	5	60 min
17	49	45	0	1	5	60 min

* indicates a comparative example outside the parameters

[0019] In this case, we compounded TiO_2 and TiO in the conductive glass sealing material so that the load lifetime characteristics of the glass spark plug with resistance was 30% less in all cases.

[0020] Furthermore, the same type of composition was obtained even when Sb, Al, Pb, Te and Zn or two or more of these were used instead of the Sn.

[0021] The reason for restricting the borosilicate group glass for the conductive glass sealing material in the present invention to 30-70 wt% is as follows. When less than 30 wt% is used, the airtight characteristics are adversely affected. When more than 70 wt% is used, the conductivity becomes unstable. In addition, the reason for restricting the wetting-characteristics-improving constituent to 2 to 23 wt% is as follows. When less than 2 wt% or more than 23 wt% is used, there is no loosening-prevention effect.

[0022] When the present invention as described above is used, the seal of the electrode shaft and the terminal shaft is tight due to the glass seal, thereby improving the durability of the spark plug.